

I CLAIM:

1. A valve operating apparatus for an internal combustion engine including:

- A housing (2);
- A reciprocating piston (1) residing wholly within the housing (2), the reciprocating piston (1) driving one or more poppet valves (7);
- A first fluid supply path (3) and a first fluid drain path (5), each path being controllable to supply or drain fluid to/from a first reciprocating piston end (16);
- A second fluid supply path (4) and a second fluid drain path (6), each path being controllable to supply or drain fluid to/from a second reciprocating piston end (17);

wherein said reciprocating piston (1), in use, is driven between a first position and a second position by controlling said fluid in said supply and drain paths (3, 4, 5, 6), thereby operating said one or more poppet valves (7), and wherein a connector (9) passes through an aperture (14) in said housing (2) to connect said reciprocating piston (1) to said one or more poppet valves (7), said reciprocating piston (1) in co-operation with an internal wall of the housing forming a seal to prevent substantial egress of fluid from the housing (2) through said aperture (14).

20 2. A valve operating apparatus according to claim 1 wherein said aperture (14) is substantially sealed by at least a portion of the external surface of said reciprocating piston (1) to prevent egress of fluid from the housing (2) through said aperture (14).

25 3. A valve operating apparatus according to any one of the preceding claims wherein a connector rod (9) fixed to the reciprocating piston (1) connects to one or more poppet valves (7).

4. A valve operating apparatus according to any one of the preceding claims wherein said first reciprocating piston end (16) and said second reciprocating piston end (17) have substantially the same surface area.

5. A valve operating apparatus according to any one of the preceding claims wherein each of said first fluid supply path (3), first fluid drain path (5), second fluid supply path (4) and second fluid drain path (6) has an independently operable control valve (24), said control valve (24) operable to have a closed,

5 partially open or open state, operation of the four said control valves (24) regulating the flow of fluid to said first and second reciprocating piston ends (16, 17), thus enabling control of the movement of the reciprocating piston (1) and hence operation of the one or more poppet valves (7).

6. A valve operating apparatus according to any of the preceding claims 10 wherein a reservoir of high pressure fluid (22) is in fluid connection with one or more of said fluid supply paths (3, 4, 5, 6).

7. A valve operating apparatus according to any one of the preceding claims 15 wherein fluid in said supply and drain paths (3, 4, 5, 6) is controlled by an engine management system controller (19), said engine management system controller (19) controlling the operation of the reciprocating piston (1) and thus enabling variable lift and variable timing control of said one or more poppet valves (7).

8. A valve operating apparatus according to any one of the preceding claims 20 wherein said reciprocating piston (1) may be decelerated by controlling said fluid in said supply and drain paths (3, 4, 5, 6) to avoid crashing of said one or more poppet valves (7) onto their respective seats.

9. A valve operating apparatus according to any one of the preceding claims 25 wherein said reciprocating piston (1) is biased (12) when in an inoperative state to a predetermined position, thereby biasing each said poppet valve (7) to a predetermined position and the biasing means (12) being prevented from acting on the reciprocating piston (1) when said reciprocating piston (1) is in an operative state.

10. A valve operating apparatus according to any one of the preceding claims wherein said reciprocating piston (1) is partially hollow, said hollow (18) providing

a surface upon which vertical force may act at least at one end (16, 17) of said reciprocating piston (1).

11. A valve operating apparatus according to any one of the preceding claims wherein said connector (9) connecting the reciprocating piston (1) to the one or 5 more poppet valves (7) allows each poppet valve (7) to spin about its longitudinal axis.

12. An engine including a valve operating apparatus according to any one of the preceding claims.

13. A motor vehicle including a valve operating apparatus according to any 10 one of the preceding claims.